

ARM-based Compute Cluster for in-situ sensed data processing

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Abstract
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A Cubesat is an ideal platform for exploration of diverse targets in our solar system. Not just one Cubesat, but swarms of hundreds and thousands. This approach has been studied in the context of the Jovian system, and the asteroid belt, by various student teams.

At Jupiter, the main problem was the communications back to Earth, the electrical power, and the radiation environment. We postulated a payload, initially, of 1,000 Cubesats, but later modified this to 333, 3-U sats. These were carried by a mothership, the same size as the Juno Mission. The individual units were networked together in the mothership, and could form a “cluster computer of convenience.”

Later, we postulated a mission to the asteroid belt, where there are a lot of interesting targets. Here, we defined a 64-node cluster computer running Beowulf. One of the big problems at the asteroid belt (actually, anywhere in the solar system) is that the Earth may be on the opposite side of the Sun from the Earth. We postulated a 64 node compute cluster on the mothership, doing science data processing, so that when the Earth was withing communications view, the data was not lost. In a similar instance, the recent New Horizons mission, at Pluto, had a transmit bandwidth of 1 kbps. It took 20 months to transmit the data from the Pluto encounter back to Earth. In this scenario, we could do several levels of data processing, to transmit partially processed data back faster.

This is based on a computer cluster of 64 Raspberry Pi-3 computers, each running linux, and linked by the Beowulf software. These would be costs units. No data would be discarded until the capacity of onboard storage was exceeded, or receipt of data at Earth was confirmed. Keeping watch over the helath of the cluster will be a Rad-Hard Arm architecture, from the ongoing AFSL/NASA High-Performance Spaceflight Program. All units will be running software units we call, rad-hard software. One example applications program that could run on the cluster is the PNN, pseudo-neural net, which is very good at extracting features and trends.